Dr E. J. Butler
with the author's
compliments.

FROM THE

GARDENS' BULLETIN,

STRAITS SETTLEMENTS.

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The Palm-weevil of Asia occurs in India, Ceylon and eastward to the Philippine Islands.

It is replaced by *Rhynchophorus phoenicis* in tropical Africa, by the allied *R. palmarum* in Tropical America and also by the smaller *R. cruentatus*. The latter seems to have a predilection for certain palms of small growth, less perhaps on account of their physical nature than its habit of flying low in the moistest air near the ground. Another similar weevil—*Rhabdocnemis obscura*—destructive to sugar cane in the Pacific islands has been found there in coconut palms.

In 1910 or perhaps one year earlier, a mischance took the Rhinoceros beetle to Samoa. It is believed that a consignment of rubber stumps from Ceylon actually carried it thither. Its presence was first noticed on November 4th, 1910, by reason of damage done to coconut palms growing close to the Customs House of Apia. From Apia it spread widely, chiefly in the direction of the prevailing wind, crossing the island of Upolu, from Apia on the north and passing westwards, but not passing so much eastwards. From the island of Upolu the beetle has flown across the strait dividing Upolu from the island of Savaii. Fears that it might reach Fiji have caused legislation to be brought in preventing the importation from the Samoan islands of anything which might carry its eggs or grubs or pupæ.

Against the pest in the Samoan islands the Government has taken energetic measures, a knowledge of which may be useful to us. Much may be learned from the two papers on it, which have appeared in Der Tropenpflanzer and from one in the Bulletin of the Department of Agriculture, Fiji.*

The first paper was by Dr. Gehrmann, an officer of the Government of Samoa, then in charge of measures against the coconut crab. He described how the mature beetle tunnels for the sake of food into the cabbage of the palm and may kill it: "the loss of palms,.... attribute to Heart-rot and to lightning" had in his opinion, he said, "during the preceeding year been due in chief measure to the beetle."

The second paper was by Mr. F. J. Jepson, Government Entomologist in Fiji, who was sent to Samoa in April, 1912, to ascertain the seriousness of the pest, lest it should be introduced into Fiji.

The third paper is by Dr. K. Friederichs, the Government Officer who now has charge of the operations against the beetle, and like the first was published in the Tropenpflanzer.

Jepson gave a map showing the area in Upolu, over which the beetle had spread in April, 1912. Friederichs has published another map bringing our information up to date and graphically showing that in spite of the strenuous measures which have been taken the pest is spreading. Since Jepson wrote it has passed over to the island of Savaii; this required the crossing of nine miles of sea; but

*Gehrmann, in Der Tropenpflanzer, xv. (1911) pp. 92, Friederichs, K., in the same, xvii. (1913) p.p. 538. Jepson, F.J., Bulletin, No. 3, Department of Agriculture, Fiji, (1912).

the strait has two islets in it, whereby the widest interspace is reduced to five miles; yet as on Savaii the beetle appeared in three villages, it is just to infer that more than one female insect had crossed the strait, and that with the wind helping, the flight can be at least five miles. However, abundant evidence shows that it is generally much less, the insect seeking a palm tree to feed in, and finding it usually near to its birth place.

As to the extent of the damage done by the beetle about the beginning of 1912, an official statement was made that one hundred and fifty trees had then been destroyed and six to eight thousand, or one-fifth of the others in the affected districts had received damage enough to put their yielding back one or two years. In April of that year, Jepson stated that about Apia and Saleimoa—the worst localities—75 per cent. of the coconut palms showed signs of attack, 30 per cent. had had their yield reduced to a great or small extent, and 1 to 2 per cent. had been killed (some doubtless by the excessive zeal of the natives in their cutting out of the beetles from the crowns). In other districts 25 per cent. of the trees had been attacked and 10 per cent. had had their yield set back.

The measures taken to cope with the beetle have been as follows. On the eighth of November, 1910, the Government of Samoa issued a proclamation in vernacular to the effect that the beetles and their grubs should be collected and promising a reward of one mark (36 cents) for every twenty beetles and the same for every fifty grubs. Seventeen days later a law was promulgated stopping coconut planting, ordering the cleaning up of all existing plantations, forbidding the using of coconut trunks for bridges and pig-styes, and arranging for inspections. About £2,000 was the cost of this method of dealing with the pest up to the end of January, 1912, and yet no satisfactory impression had been made on its numbers. Therefore on the first of February, 1912, it was made compulsory to search for and destroy the insect. Following this there was issued on April 19th, 1912, a decree calling into being a commission with powers to inspect and compel owners of coconuts to keep their estates clean, and to remove structures made of coconut trunks, or standing dead trees at the owner's expense. Then on the 10th of May, 1912, appeared an order requiring all able-bodied persons in the affected districts to turn out at six o'clock on every Wednesday to search for beetles and grubs which were to be brought to the village headmen, counted and destroyed by fire or hot water. Into this great holocaust passed the grubs of beetles which happen to be similar to those of Oryctes. Friederichs names them specifically; but their number is a matter for estimation. From the 1st of April, 1912, to the 31st of March, 1913, roughly, ten million grubs and a quarter of a million beetles were collected and killed on the island of Upolu; allowing for the grubs of the similar beetles, Friederichs puts down the Oryctes larvæ destroyed as six million and the beetles as two hundred thousand—a nice little family originating in a few grubs imported in 1910 or possibly 1909.

To this figure has yet to be added the number of the grubs and beetles collected on the European Plantations. On the estate of the Deutsche Handels- und Plantagen- Gesellschaft der Sudsee-Inseln zu Hamburg over the same period were collected and destroyed about 350,000 grubs and 23,200 beetles. Further the number of insects trapped by the Commission over the same period was 180,000 eggs, 776,000 grubs, 220 pupæ and 11,300 beetles. The traps will be described next.

For the making of a trap a hole is dug in the ground from nine to twelve feet square, and about two and a half feet deep. Rotten coconut stumps, plantain stems, and soil are put into it; and over the top large leaves such as coconut leaves, breadfruit leaves, and plantain leaves are placed rising perhaps a foot above the surface of the soil. Into these pits the female beetles penetrate to lay eggs and the male beetles to find the females. What beyond digging the traps is necessary is that they should be opened at regular and a not too distant periods, or that the beetles in them may be in some way killed.

At distances of about one hundred yards along some of the roads in Samoa these traps have made in series, and on the plantation of the Deutsche Handels- und Plantagen- Gesellschaft there is one trap to every hundred standing trees.

On the latter estate the traps are opened every six weeks or two months.

Jepson states that it takes six men about two and a half hours to open and remake one trap; therefore six men can attend to four traps only per diem, or in rotation 160 to 200. He suggested that the traps might be treated with bi-sulphide of carbon and not unpacked at all. Six ounces of carbon bi-sulphide were accordingly injected into a full sized trap, which after an interval of twenty-four hours was opened. Then all the larvæ in the trap—450 in number—were found dead; three mature beetles were partially asphyxiated, but recovered; rats and mice were found dead. The trap was remade, and re-examined eighteen days later, when to that officer's satisfaction it was found to be again full of beetles, showing that the treatment did not destroy its usefullness, but rather increased it, as a record catch was made. A second trap treated with nine ounces of carbon bi-sulphide at the same time, but opened thirty six hours later, contained 249 dead grubs and one dead beetle.

Unfortunately the German officers discovered that the cost of carbon bi-sulphide in Samoa is too high to make the method worth adopting. The building of traps, however, is a useful proceeding so long as the organisation for inspecting them is efficient; for as we saw above by their means in 1912 the Commission collected 180,000 eggs, 776,000 grubs, 220 pupæ and 11,300 beetles.

Friederichs further gives the following figures to show that the traps are efficient for catching the male insects as well as the female:—out of 1,000 insects taken, 566 were females and 434 males.

Of the lessons to be learned from this Samoa outbreak, the outstanding one is that the beetle is enormously prolific when unchecked. Regretfully we learn too that man cannot keep it down, for it has gained ground in spite of strenuous direct efforts against it; it ought probably to be attacked through its natural enemies—parasitic ichneumon flies and Tachinid flies. These, however, will never serve instead of cleanliness about the plantations and the removal of that in which the grubs prefer to mature.

In German East Africa the method of collecting the grubs and beetles by paying so much for them was adopted some years ago.

It seems that there planters had put out coconuts on virgin forest soil which was full of grubs living in rotten wood in or on the soil, and so they had courted the beetle. At any rate its abundance alarmed them and rewards were offered for the collection of the grubs and beetles. Preuss (Der Tropenpflanzer, xv. 1911, p. 73), says that in October, 1899, on the Muea Plantation of the German East Africa Company 140,000 were taken from the ground at a fixed sum; . . . in Dar-es-Salam in June, 1907, as the result of an offer of a sum for each grub . . . there was a grub-fever among the natives and within a few days 25,000 to 30,000 were collected and destroyed.

In the region of the natural distribution of the Rhinoceros beetle, viz, India to the Philippine islands, a not inconsiderable amount of attention has lately been directed to the damage done by it in various quarters, not so much because of any outbreaks as because Economic Entomology has come to the front. Messrs. J. McKenna and K. D. Shroff do indeed claim that it has lately invaded Tenasserim (Bulletin No. 4 of the Department of Agriculture, Burma, 1910, p. 3), but it is hard to believe that this should have been the case; rather is it more likely that the increase of industries which leave vegetable refuse about, such as saw milling, are responsible for an increase in the numbers of the insect. This might particularly be the case about Rangoon, where it was said that so abundant had the beetle become in, and from 1907 that the very existence of palms in the neighbourhood was threatened.

The laying out of new coconut plantations in Ceylon by European planters brought the beetle to notice through the colony, but especially in the Batticaloa District, where the new plantations chiefly were: and 1903 saw an agitation for legislation against those who allow it to mature.

In the Philippine islands at the other end of the insects limit American enterprise brought to bear on the backward agriculture, turned the light on to it; and of the coconut groves, heavily grassed over and full of fruitless trees, Mr. C. S. Banks said, in 1906, that he found scarcely a tree not marked by its ravages.

From the latter's pen and from that of Mr. C. C. Ghosh, Assistant to the Imperial Entomologist, Agricultural Research Institute, Pusa, India, have come new studies of the life history and manner of working of the insect.

The insect is too familiar to need any description, but there are still several points in its life history, whose obscurity will be brought out by the following paragraphs.

The mature beetle is noctural, generally shunning light and very anxious to hide when exposed to daylight. Ridley (Report on the Destruction of Coconut Palms by Beetles, Journ. Asiatic Society, Straits Branch, No. 20, 1889) says that the insects may be attracted to fires lit in the plantations by night; and Ghose states that they fly to light in Behar, in the Ganges valley, and suggests that they may be trapped by light traps; but others have concluded that lights have not influence enough on the beetle to be worth using. At night both sexes fly abroad in search of food and in search of each other. By preference they do not fly far. Both sexes for the purpose of feeding alight in the tops of coconut palms and other palms†; there they seek the softest spots and commence to burrow with their powerful mandibles. After half an hour's work they are about one quarter of an inch into the tissues; at dawn they have penetrated at least more than their own considerable body-length. Young palms, which are growing fast and so expose a greater length of rather soft tissue than do the old palms are on this account more exposed to attack; perhaps also, they are more attacked because their soft parts lie in the still damp air near the ground, whence the beetle may have emerged and whither, if female, it probably will go to lay eggs. The beetle chews the tissues as it burrows swallowing the juice but ejecting from its jaws the fibrous parts. At first it burrows chiefly for the sake of a lair, but as it wants fresh food throughout its life, it continues its tunnel to feed. It is a matter of chance in what direction the tunnel goes; if by chance it reaches to the centre of the growing apex of the stem, the tree is killed; again if the hole so lies open that rain water gets into it rot sets in and again the tree is killed. But fortunately for the most part the beetle finds food enough in the young leaves enwrapping the apical bud, and by boring transversely through these, tangentially to the apical bud, cuts them while folded so that on emerging from the bud they appear as trimmed,

† The following palms are recorded as attacked by the Rhinoceros beetle :—

Cocos nucifera—the Coconut, *Cocos plumosa, Martinezia caryotæfolia, Phœnix dactylifera*—the Date palm, *Phœnix sylvestris, Livistona chinensis, Verschaffeltia splendida, Dictyosperma album, Hyophorbe amaricaulis, Elaeis guineensis*—the African oil palm, *Corypha umbraculifera*—the Talipot palm, *Corypha Gebanga, Borassus flabelliformis.*

topped, or belted. The damage so done can be measured in the proportion of leaf tissue cut off; in severe cases it amounts to a set back of one year. Rarely does the insect directly kill the tree; but we do not know how often. In Malaya it is certainly common to ascribe to lightning the work of the Rhinoceros beetle.*

The beetle must be attracted to the trees by some chemical substance; and it has been suggested that this is to be found in the odour of the sap, but Friederichs experimented with palm toddy fermented and fresh, and did not take a single beetle thereby. The observation is curious, for it is known that attacked trees may become favourite trees and one boring is followed by another. However, as Friederichs found that the sex odour of the beetles is attractive, we perhaps find an explanation for the repeated attentions of the beetles to one tree in the attraction of a beetle for more individuals of the other sex than one, and the surplus insects being unwelcome in the mating burrow, excavate one of their own in the same tree top.

The beetles of course find some attraction in the decayed material which they seek for egg-laying. Friederichs combining the attraction of rotten cocoa husks with the smell of a large number of imprisoned beetles of both sexes, and placing a light over the cage caught in eight nights ten females and twelve males which were attracted. The catch seems small, and as he remarks hardly worth making.

It is certainly no odour of the flowers, which attracts the beetles, for long before flowering they are attacked; and a writer in the Tropical Agriculturist (Beven, on p. 111 of N.S. vol. xxiv., May, 1905) says that the king coconut is particularly liable to attack in the alternate years between flowering.

The beetles mate in the holes that they make, but rarely lay eggs in them. The eggs are deposited in decayed vegetation wherever that may be; and it is possible that the undoubted cases of egg-laying within the burrow have been induced by some decay within it. Perhaps the burrower has struck an old hole with decay in its sides; but events which take place in the tops of palms are rather hidden from the eye of man. Let it suffice to say that undoubtedly the female rhinoceros beetle does sometimes lay eggs within the burrows, and that then destruction of the tree follows. The writer knows well that the very first signs of decay in a felled palm top are signals for the appearance of young larvæ from eggs there deposited.

Into the holes penetrate the Palm-weevils to lay eggs, and in giving them access to the soft tissues is the unpardonable crime of the Rhinoceros beetle.

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* Cf Koningsberger, J. C., Mededeelingen van 'Slands Plantentuin, xxii. (1898) p. 42.

The Rhinoceros beetle probably lives long as a mature insect; but observations are wanting. Without food Ghosh found it to live for three weeks. If dissected, very few eggs can be found in the female at any one time, and Ghosh observed that they are laid, say, three on one day, two on the next, two on the following day, and so on, each egg apart from any other.

But unless this slow egg-laying continues over a long period how could one get the millions of grubs which were collected in Samoa? The eggs, Ghosh found, were laid at night. The grubs hatched out after ten to twelve days, at the beginning of June. On the twentieth of October, grubs from these same eggs appeared to him to be full grown. Where Ghosh worked, a cold dry weather sets-in, in October, and is followed by a hot dry weather lasting until June. Ghosh's beetles made no progress during the cold dry season, though they were not dormant. One beetle only survived it and emerged on the fifth of May, having taken nearly twelve months to complete its cycle.

Yet it seems probable that in warmer damper countries such as the Malay Peninsula, growth is continuous and the life-cycle shortened to fewer moths; if this were not so we should find a greater proportion of large full grown grubs than we do, and the writer has some reason for thinking that six to seven months are enough for the beetle to pass from one generation to another: and again supposing that four grubs were introduced into Samoa in 1909, two of each sex, and that they matured and laid eggs, so large a supply as was present in 1913 requires that each female should have deposited considerably more than two hundred eggs, if the period of one generation be twelve months; but if the period of one generation be six months, fifty-four millions might be reared from two females laying fifty eggs apiece.

The grubs are blind, and very soft-skinned behind the head. Five minutes exposure to sunlight kills them at maturity. They have a breathing apparatus capable of being closed, which is an adaptation for living in almost liquid decaying matter. Their demand for moisture is very great. We can kill them easily by letting them dry, and conversely we can greatly encourage them by supplying to them damp coconut stems. There is a no more mischievous practice than that of lining the banks of a ditch or stream with coconut logs and every such place must be ruthlessly destroyed. The practise of using coconut logs for bridges is only a little less obnoxious, and should be stopped. The leaving of stumps in the ground in dry places through dry weather is not obnoxious; but the leaving of stumps in the ground in wet places and in wet weather is; and as sooner or later wet weather comes on the once dry stump becomes damp enough for the beetle-grubs to grow in it. The necessity for removing such stumps depends on the length of time that they are likely to remain damp enough for the grubs—whether it may be a period approaching their (apparently) six months course of growth or less.

Upright tall dead trunks commonly harbour grubs, for the wood decays faster than the bark and a cup which catches rain is formed just suitable to the beetle.

Now it is not to be thought that the coconut stump is the only one to be removed; the beetle can live in many palms apparently as well as in saw-dust of soft woods of trees that have no relationship to the palms. It can live in manure heaps, and old tan heaps; all such heaps should be turned over (if it is necessary to keep them) at least once within the period of the life time of a grub, viz., six months (which period it were better to reduce to three for safety). In turning over the heaps, grubs exposed to the sun will be killed. Old decaying thatch in which it can live, should not be left to breed the beetle. When full fed the grub makes for itself a case in varying fashion; it seems as if it took to rotation and when lying in fibrous material thereby arranged the fibres more or less concentrically, or if lying in earthy material compacted for itself a wall. In this case it turns to a pupa and from it emerges a mature insect, ready to attack the living palms.

The Palm-weevil—*Rhynchophorus ferrugineus*—also has been studied by Ghosh, at Pusa in the Gangetic plain. He bred it in March, April and May and he found that it passed through a life cycle in about two months. As well as from its more destructive habits as from so rapid a course it is more dangerous as a pest than the Rhinoceros beetle; and when, as there has been recently in Singapore, an outbreak of it occurs, we cannot afford to let three months go by as in the case of the Rhinoceros beetle, but must pay constant attention to the infected spot. It breeds at all seasons, and there is no evidence that the cold weather of the Gangetic plain retards its growth, through there is some evidence that egg-laying may be retarded as is the case with the American Palmetto weevil *Rhynchophorus cruentatus.**

The mature beetle seeks the tops of the palms chiefly by night, but also by day, and with its long snout makes a small puncture, into which to the best of its ability it places an egg. If entry is to be had to the inside of the palm by a ready-made hole so much the better for the weevil and the worse for the palm; full advantage is taken of all such holes. In a hole, according to Banks, it does without making any appreciable puncture, but pushes the egg into the tissue a little way. The eggs are laid several upon one tree, near together but not in contact, and if laid from the outside, not within one of the Rhinoceros beetle's borings,—are placed ¼ to ¾ inch deep in the tissue, right at the bottom of the puncture. Eggs were laid in Ghosh's laboratory by day as well as by night. One insect deposited 276 eggs in a life time of 49 days, another 127 in 46 days and four kept together 213 in 24 days. The greatest number of eggs laid

*Summers in Canadian Entomogolist, v., p. 123.

by a single female on one day was 32. The grub, like the grub of the Rhinoceros beetle, shuns light and is easily killed by exposure to the sun; it likes much moisture so that the hacking open of stems in which they have been growing and the exposure of them, is a good preliminary operation whenever an attacked palm has to be cleared away. They seek the softest tissues of the palm and therefore the very heart, and if left undisturbed they kill the tree with a certainty which is foreign to the Rhinoceros beetle. They do not need the tissue to be absolutely healthy, but finish their growth in dying palm stems among most obvious decay. At maturity they make a case twisting fibres from the stem round themselves and to reach the fibres they have to approach the outside of the trunk which they do close to some place from which they can emerge. The twisting on the eve of pupation is only an exaggeration of the grubs ordinary movements in progression. The pupa stage lasted, under Ghosh's observations, about 25 days.

The most rapid growth recorded by Ghosh was of one insect which emerged as a perfect beetle, 48 days after the egg was laid; 54 and 56 days were quite common periods.

The palm weevil feeds on other palms as freely as on coconut palms. It is recorded as destroying *Oreodoxa regia*,—the Royal palm, *Borassus flabelliformis*, *Phœnix sylvestris*, and the writer has found it in *Arenga saccharifera* and *Elaeis guineensis*. Such palms require watching as do the coconuts for signs of the presence of the grubs, because outbreaks may commence in them and spread to the coconut palms.

Blanford, in an interesting paper on the American Palm Weevil (Kew Bulletin, 1893, p. 37), refers to a very reasonable belief that the period when that insect became a most serious pest in British Honduras began with the giving over to cultivation of ridges where the *Attalea* palm grew. The Attaleas were felled and left to decay, whereupon the weevils multiplied excessively, and flew when their food on the ridges existed no longer, to the near coconut plantations, doing there very extensive injury.

As in the case of the felling of the *Attalea* palms in Honduras, so now in Malaya during the current vogue of removing coconut palms from among rubber, we have a menace to the coconut plantations. A young coconut, such as is so often cut, affords to the palm weevil a splendid breeding ground; it is nutritious from top to bottom, and the beetle is very prompt to take advantage of it.

This is a fact worth remembering; and experience lately in Singapore Island has shown that double vigilance in coconut tree inspection is required, while land owners, of small means and small knowledge, or it may be wanting in public spirit, continue the felling of coconut palms on their properties.

SUMMARY.

The Rhinoceros beetle, though laying eggs slowly, can multiply with great rapidity and as it in all places seems to kill a few coconut palms, when it is unchecked the amount of destruction done may mount up to something appreciable (upwards of 1—2 per cent. in the worst localities in Samoa); beyond the destruction there is a reduction of the yield in less severely attacked palms. Young palms are more liable to its attacks than old ones, partly because they stand in the still or moist air near the ground where the mature beetle seems chiefly to fly, but more because of the greater length of relatively soft tissue which they offer to attack.

The mature beetle tunnels in palms for the sake of food, making its tunnel a lair; it usually burrows through the enfolded young leaves and does not reach the heart of the cabbage and so does not kill the palm: it probably lives for several months, the female steadily laying eggs throughout the period, but the duration of life and the continuance of egg-laying are matters of conjecture. The beetles, and their grubs, shun day-light: they mate in the feeding tunnels or else in the places where the eggs are laid. They sometimes fly to light at night, but not with sufficient readiness for lights to be used as traps. There is something about a palm attractive to them, but it is not the odour of the drawn sap nor of the flowers. The opposite sexes have an attraction for each other; but the caging of the one to entrap the other is only moderately effective. Eggs are laid in decaying vegetation, and when as sometimes happens they are laid in living coconut stems, it may be that some decay had already been set up in an old wound. The smell of decaying vegetation, particularly of decaying palm stems is very attractive to them and may be used for the making of traps. The eggs hatch in 10-12 days, and the grub seems to require about five months for maturing; then it pupates and remains for a brief time as a pupa, emerging a beetle, it would seem, within seven months of the laying of the egg, unless cold or dry weather delays it.

The grub is very thin-skinned, and requires moist food; it can live in very moist food (slush). Exposure to dry air very rapidly kills it.

The way to attack the insect is to remove its food-supply, for although within the region of its natural distribution there are doubtless parasites and enemies, which do something in the way of keeping its numbers down, we know nothing of them, nor are we likely at present to use them to effect. Where the insect has appeared in excessive numbers, the cause has been man, in most, if not in all cases; usually man by putting an exceptional amount of food in the way of the insect, has given it the means of unduly increasing. It behoves us to keep all vegetable refuse under control both in the plantations and about neighbouring tan-yards, saw-mills and villages, for the beetle is not of restricted flight. Old coconut stumps and trunks

sooner or later become vegetable refuse, which must be removed. Traps such as those described above, are effective in direct proportion to the cleanliness of the area in which they are.

When many stumps have to be removed the cheapest method of destroying them is by the use of explosives.

The Palm-weevil goes through its life-history more rapidly than the Rhinoceros beetle; and it would seem that it should multiply more rapidly, as the female can lay nearly 300 eggs within fifty days, but that it is less in evidence is probably due to the circumstance that it is so much more particular about its food; it may be also that it has more enemies, but this we do not know. In any case it is to be remembered that an outbreak of it would be more rapidly destructive than one of the Rhinoceros beetle.

The female lays her eggs in living palm tissue, taking advantage of wounds, of which the commonest are those made by the Rhinoceros beetle; the mature beetles also feed on the palm tissue. If the female finds no hole in the palm, she makes one for herself, but only ¼ to ¾ inch deep; into it she places one egg; if she finds a Rhinoceros beetle tunnel she pushes eggs into its walls. The nearer to the heart of the tree the eggs are placed, the more serious must the attack be; the heart of the attacked palm is then tunnelled through by the fat greedy grubs, and its top falls over, declaring the presence of the invader only when the damage done is past repair. Though the grubs may not be mature when this happens, they finish their course in the tissues. The eggs may be laid also in palm tissues commencing decay.

Soft decaying palm-tissue should never be left lying about the estates to the advantage of the beetle, neither of coconut palms, nor in a general way of other large palms, for though there are palms in which the tissues hold abundant needle-crystals, until a palm, whatever it be, has been proved unpalatable to the grubs, it should be looked upon as possible food for the weevil.

I. H. BURKILL.

CLEROME GRACILIS,

a Butterfly destructive to Palms.

A social caterpillar with a yellow head, black body, densely covered with long hairs which are rusty red above the base, and freely come out, irritating the human skin, had been found doing damage to Rhopaloblaste palms in the Botanic Gardens. It was reared to maturity and proved to be *Clerome gracilis* Butler.

The caterpillars, both when feeding and when resting, take line from each other: they stand parallel on the lower surface of the leaf that they are or have been eating. They feed at night and rest by day.

When mature, they are nearly two inches long.

The chrysalis is of a brilliant green, angular as that of the familiar tortoise shell butterfly (*Vanessa urticæ* Linn) and hangs by the tail from the under surface of some object.

The butterfly is of a rich brown colour.

I. H. BURKILL.

NOTES ON PLANTS OF INTEREST IN THE BOTANIC GARDENS, SINGAPORE.

Porphyroglottis Maxwelliae, Ridley.

Among the orchids which flowered in the Botanic Gardens, Singapore, in 1913, was *Porphyroglottis Maxwelliae*. This strange orchid of still somewhat doubtful affinities was described by Mr. Ridley in 1896, from dried specimens and drawings sent to him from Sarawak. Otherwise it has remained unknown, and living plants had been in no Botanic Garden, until a small collection from Dutch Borneo was offered to him for purchase in 1911. By chance *Porphyroglottis Maxwelliae* was in the collection.

A new Variety of Eria gracilis, Hook. f.

An orchid which has recently flowered in the Botanic Gardens is *Eria gracilis* in a variety not described. The lip is obcuneate, with the middle lobe reduced to a minute point overtopped by the truncate side-lobes. It may be called var. *obcuneata*.

There is a label on the Singapore plant calling it a "Dendrobium from Java." Possibly this label has been transferred from another plant, for *Eria gracilis* is a local orchid of Singapore, extending northwards to Penang, but unknown in Java.

The flowers are flesh-coloured with sparse crimson hair outside and the lip has a crimson line down its very margin, as in the allied *E. oligantha*, Hook. f.

A new Variety of Sarcochilus stenoglottis, Hook. f.

A variety of *Sarcochilus stenoglottis* flowered in the Gardens early in August. Unfortunately the origin of the plant is unknown.

Sarcochilus stenoglottis was described by Sir Joseph Hooker in the Flora of British India, vi. (1894) p. 34; and a plate is given in the Annals of the Royal Botanic Gardens, Calcutta, v., (1895) t. 62, a reproduction of a sketch made in Calcutta in 1883, from a plant obtained in Sumatra by Kunstler.

The plant which has come under observation has red colour neither in the peduncle nor in the flower; and the margins of the lip are not frilled, but even.

A drawing has been placed in the Singapore collection.

Habenaria Havillandi, Kränzlin.

In 1912, Mr. J. W. Anderson, the Assistant Curator, was sent on a collecting trip to Sarawak, whence he brought back a series of interesting plants. One of the plants proved to be the orchid *Habenaria Havillandi*, Kränzlin. Large green flowers are always interesting, because the number of species having them is small; *H. Havillandi* is one of the number. The flowers, vertically from the tip of the upper sepal to the tip of the labellum, measure 2 cm.; the spur is long and full of honey at the lenticular end; the flowers have a faint but pleasant scent. Many of them are open together, so that in a conservatory with a setting of flowers of other colours this orchid is quite conspicuous. It flowers twice a year.

The explosive Flowers of Plocoglottis porphyrophylla, Ridley.

Another orchid, brought back by Mr. Anderson from Sarawak, proved to be *Plocoglottis porphyrophylla*, a plant of wide distribution in Malaya, but because inconspicuous and a lover of deep shade, little known. The Sarawak plant carried only one flower open at a time, but it remained in flower over more than three months, producing a fresh one every few days until the raceme was more than two feet long, and had borne fifty. Specimens and drawings in the Singapore herbarium indicate that sometimes two flowers may be expanded at the same time; this, however, never happened in the plant which came under observation.

The flowers have a most conspicuous asymmetry, are explosive, and exhibit an extraordinary series of changes, which have passed undescribed hitherto; indeed the existing descriptions of the flower are quite inadequate for giving any true idea of its appearance. Other species of Plocoglottis have bilateral symmetry, and seem widely distinct enough from our subject.

It is convenient to begin the description of the flower by an account of the half-grown bud.

The ovary begins to twist, as is the way in orchids, when by its growth it has overtopped the bract; it carries the swelling bud through about 75 degrees and then stops twisting. During this twisting the dorsal sepal outgrows the other sepals pushing over the apex of the bud. If the bud be dissected the tips of the lateral petals will be found within the apex, but the lip only slightly overpasses the middle of the bud.

All the sepals at this stage are similarly narrowly ovate, the lateral sepals being asymmetrically so. The lateral petals are linear, and curved round the column to meet at their tips. The lip is nearly as broad as long, cuspidate above its broad shoulders, with the margins in the lower part frilled and turned under. If these margins be uncurved it will be seen that they are the lateral lobes of the lip. Under each broad shoulder a wart has begun to form: three lateral nerves end close to each of these warts.

Between this stage of the bud and maturity the following changes take place. The contiguous halves of the lateral sepals thicken from the middle upwards; the cuspidate tip of the lip turns back, its shoulders enlarge and the warts become sharp little upstanding cones, while the side lobes increase along their margins so that they are too full for the space that they have and towards the base of the lip tend to form an upstanding rounded crest.

Two very fleshy bodies, being the staminodes, lie within the curve of this crest, one on each side.

The opening of the flower takes place late in the afternoon or in the early part of the night. In it, as a commencement, a slit appears between the lateral sepals from the middle, downwards first, and then to the tip. Next these lateral sepals break away and slowly take a position at right angles to the ovary, and their thickened areas begin to become convex inwards and throw the thin parts back. Following this movement the lateral petals rapidly elongate, curving over strongly so that their points pass between the bases of the lateral sepals, and in this curious action they deflex the lip on its base holding it down against a certain amount of resistance, in contact with the lateral sepals. Thus the flower gapes somewhat.

If in the early stage of the flowering, the lateral petals are cut, the lip springs up elastically against the column, being forced up by the turgid tissue at its base and perhaps in less measure by the pull of the margin. Meanwhile the dorsal sepal has not moved.

This is the first stage of the flower and lasts into the night. It is accompanied by the development of two eccentricities: one of these is a movement of the column towards the right hand side of the flower (right hand of an observer facing the flower), whereby later it comes into contact with the shoulder of the lip; the other is the unequal curving of the lateral sepals, the upper curving most, whereby they come to form a platform with their swollen areas presented forwards and upwards, and one, the upper, presses on the tip of the labellum. The bilateral symmetry which was present in the bud is now completely lost.

During the night the second stage comes on, beginning with the turning back of the dorsal sepal, and continued by the straightening of the lateral petals. The upper of the lateral sepals no longer held away from its fellow by the lateral petals, now moves down to be in contact with it, and is thus almost median as regards the lip, and as

the lateral petals move away the lip is left caught lightly against its convex swelling, and held folded down as the lateral petals placed it. A touch now frees the lip and causes it to spring up against the column, its right shoulder being under the pollinia. Pressed thus against the column it remains while the flower withers on the following morning. In withering the lateral petals curve inwards until their tips meet; the lateral sepals rise up until they touch the lower side of the lip; the dorsal sepal follows; and the life of the flower is over.

It has no scent as far as the human nose can test it. It has no free honey. Its colours are lemon yellow to yellowish green with deep crimson markings on the lip; and the swollen parts of the lateral sepals are maroon.

How it is fertilised it is not possible as yet to state, but it would seem likely that insects of rather small size, attracted to the flower, are trapped by the up-springing of the lip against the coloumn, and in struggling to free themselves effect pollination. Sections through the swollen parts of the lateral sepals show that this tissue contains large cells with raphides towards the outer surface, and small cells towards the inner.

The mechanism is most curious; the lip is a trigger put into place by the lateral petals, and held there by one of the lateral sepals. This alone makes it of unusual interest; but the interest is heightened by the angle at which the flower stands, by the movement out of the median plane of the column, and by the movement towards it of a lateral sepal.

Hapaline appendiculata, Ridley.

A third interesting plant brought back from Sarawak by the Assistant Curator is *Hapaline appendiculata* with variegated leaves. Mr. Anderson had found it plentiful near Bau. It flowered in cultivation in the end of May.

Hapaline appendiculata differs from the two other known Hapalines in having an appendix to its spadix, which slightly overtops the narrow white spathe. Is is the most southern representative of a rather badly constituted genus. It was once before in cultivation in the Gardens, but either was lost or is bedded out in some unrecorded nook under the trees. The specimen grown earlier had dark green leaves without the conspicuous pale green cloudy markings of the new one. The leaves take a peculiar attitude, the petiole bending so as to place them beyond the rim of the plant pot in which they may be grown.

I. H. BURKILL.

THE EXTREME HARDNESS OF THE SEEDS OF CAESALPINIA DIGYNA.

In 1910, the writer obtained two dozen seeds of *Caesalpinia digyna*, Rottl., from Burma, intending if possible to isolate on them the water-resistent layer which hinders the germination of quite a number of the Leguminosae, such as *Acacia arabica* and various indigos. The intended study was never completed; but observations were made on the resistance of the seeds to germination.

The seeds were placed half-submerged in clean water, which was frequently changed, but none germinated during nine months; next they were allowed to dry and after about three months out of water, they were placed in it again half-submerged as before; still there was no germination. A few were removed from the experiment to see if they were alive; they were cut slightly so that the impervious layer was broken, whereupon they all germinated. The remainder passed another six months half-submerged, but did not germinate; then they passed a year dry. Half-submerged again for the third time, as before they did not germinate during two months.

It seemed probable after this that the alternation of wet and dry seasons such as occurs where the plant chiefly grows, has nothing to do with the germination. However, it was thought that perhaps jungle-fires might bring it about; and ten seeds were accordingly placed under a layer of dry leaves prepared to produce a flame a foot high, which was fired; the seeds, when the fire had passed from them, were collected and replaced again in water, they still did not germinate until they were cut. With this the experiments ended, the supply of seeds being exhausted; but the living plants now in cultivation in the Economic Garden, Singapore, are the offspring of these seeds.

It seems as if *Caesalpinia digyna* only germinates after direct injury to the outermost layer of the seed-coat.

Several years ago Professor W. R. Dunstan, Director of the Imperial Institute, London, showed what splendid leather is produced by tanning with the pods of this plant, but a barrier to its use was found in the high cost of collecting them from the bushes which grow too scattered. Should it ever be possible to bring the pods into the market, it is most likely to be by encouraging the plant to grow thicker by sowing prepared seeds in waste places.

I. H. BURKILL.

A DISEASE OF AGAVES.

There is a disease on *Agave* plants in Singapore, and in the state of Johore, due to a fungus. This fungus attacks the mature leaves on the upper surface, rendering them valueless for the

extraction of fibre. The first sign of it is the appearance of white blotches which spread, then darken to a deep brown, becoming sunken, and when quite dead the skin takes on a rather silvery look; this change is followed by the breaking out of small black pustules which are often in rather regular concentric rings.

On cutting sections of the diseased parts of the Sisal plants it can be seen that in the earlier period of the attack the bleaching is due to the destruction of the chlorophyll-containing cells under the epidermis, whereby cavities are formed leading to the shrinkage of the dying epidermis onto the layer of fibres below. The whole afterwards becoming more and more disorganised, air obtains access to the cavities; and this leads to the silvery appearance. In the final stage spores of a fungus are formed in the cavity under the epidermis and escape through cracks in it.

The attack is like that of the fungus *Colletotrichum Agaves* which is described and figured in the Sixteenth Annual Report of the Missouri Botanic Garden, 1905, p. 153, plates 35-37, but the destruction seems to spread more longitudinally down the leaf, and under the microscope it is seen that the spores are not the spores of a *Colletotrichum,* but of a fungus of the allied genus *Coryneum.*

Coryneum and *Colletotrichum* both belong to the Melanconiales, and as they are of the same habit, the treatment for one would seem to be the treatment for the other.

Colletotrichum Agaves is known to occur in India, and may be attacked as recommended by Dr. Butler, in the Agricultural Journal of India, i. p. 260, thus :—

"Sisal Hemp Disease. A disease of cultivated Agaves, caused by the fungus *Colletotrichum Agaves* . . . . . has been found in several parts of India, and has been the cause of alarm on Sisal estates. In America it has not been known to attack Sisal; but in India it often does so. The older leaves are first attacked, sunken patches appearing where the fungus has entered. These turn brown and dry up in the centre, while they spread at the margin. In the dried up parts, spores are produced in little black clumps, which blow about and infect healthy leaves . . . . . All diseased leaves should be cut and burnt as soon as the patches appear."

In the Report of the Missouri Botanic Garden, it is recorded that the garden authorities had succeeded in checking the spread of the disease by such means; but it is added that moisture predisposes to the attack. Missouri with its dry climate then has a great advantage over this country where we cannot avoid the moisture.

I. H. BURKILL.